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SHORT-TERM MISSILE CONTROL SYSTEM USING TRANSVERSE FORCE THRUST GENERATORS
[EINRICHTUNG ZUR KURZZEITSTEUERUNG EINES FLUGKOERPERS MIT HILFE VON QUERKRAFT-SCHUBERZEUGERN]

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Patent Claims /1*

1. A system for short-term control of a missile by means of controlled-ignition transverse force thrust generators, wherein each transverse force thrust generator (2) continuously generates a thrust jet (5) over its entire operating time after ignition, in at least one position communicates with an exhaust opening (10) provided on the circumference of the missile (11) for generating the transverse force and in at least one further position does not communicate with the exhaust opening (10), and thus generates no transverse force to the missile (11), the transverse force thrust generator (2) is held in a definite position by a tightened tension element (9) fastened to the missile (11), and the connection between tension element (9) and transverse force thrust generator (2) is detachable for releasing and transferring the transverse force thrust generator (2) to another definite position and the transverse force thrust generator (2) can be moved into this other position in a driven manner.

2. The system according to Claim 1, wherein several elements (9-1 to 9-6) are provided for the transverse force thrust generator (2'), the lengths of which are determined one after the other so that after /2 breaking the respective connection of a tension element (9-1) holding the transverse force thrust generator (2) in a specified position, the next longer tension element (9-2) holds the transverse force thrust generator (2') in a further specified position.

*Numbers in the margin indicate pagination in the foreign text.

3. The system according to Claim 1 or 2, wherein the tension elements (9-1 to 9-6) in each case are electrically conducting and are part of a circuit containing a battery (13) and a switch (12).

4. The system according to Claim 3, wherein the tension elements (9-1 to 9-6) in each case have a nominal melting point (23).

5. The system according to one of the Claims 3 and 4, wherein the tension elements (9-1 to 9-6) are wire fuses.

6. The system according to one of the preceding Claims, wherein a rotary nozzle (2) is used as a transverse force thrust generator, that emits a propellant jet out of an acentric thrust nozzle (8), the direction of action of which does not pass through the axis of rotation (A) of the thrust nozzle, and the tension elements (9-1 to 9-2) engage on a cylindrical circumferential part (22) of the rotary nozzle (2).

7. The system according to Claim 6, wherein a tension element (9) is wrapped around the rotary nozzle (2).

8. The system according to Claim 6 or 7, wherein a propellant charge (6) is received in the rotary nozzle (2) for generating the thrust jet (5).

10. The system according to one of the Claims 1 to 9, wherein the transverse force thrust generator (2') within the missile (11') is mounted moving longitudinally and is held in its specified position by means of the tension element (9). /3

The invention concerns a short-term missile control system using controlled ignition transverse force thrust generator. /4

A plurality of systems are known for short-term control, in particular of closed-tube projectiles. It is possible to distinguish between those systems, the transverse force thrust generators of which no longer can be influenced after ignition and those systems in which influence is not possible.

DE-PS 28 09 281, or example, is to be consulted for the first-mentioned type. There is here a plurality of thrust generators distributed around the circumference of a missile with autorotation, that exist of very small powder drive assemblies, that are ignited according to a predetermined control procedure. After the ignition the propellant charge of a thrust generator burns off within a very short time. The operating time is around 1/300 seconds. This time is not variable, so that several thrust generators must be ignited one after the other for generating a transverse force acting over a longer time period.

The applicant's DE-OS 33 17 583 may be named as an example of the second type. In this case a rotary nozzle, through which a propellant gas of a gas generator flows and that has an acentric thrust nozzle, serves as the transverse force thrust generator in this case. The rotary nozzle rotates, without exerting an influence, at a high speed around the longitudinal axis of the missile, but can be held in specific positions, and released from the latter, by means of a braking system, for example a magnetically actuated friction /5

coupling. In these specified positions the thrust jet emerges radially outward from the thrust nozzle through an exhaust opening in the missile and generates a transverse force or it is exhausted in a neutral direction, without generating a transverse force on the missile.

This device is very well suited to steer rapidly flying missiles during a relatively long span of its flight time. A more rapid and frequent exchange between zero and full command is possible with corresponding dimensioning and control of the braking system.

In some cases, a frequent correction of the flight path of a rapidly flying missile is not necessary, for example in the case of closed-tube rapidly flying projectiles, the flight path of which has to be controlled in the final flight phase to the target only once by means of specific commands.

The object of the invention is to propose a device of the type in question for steering a missile, that is designed mechanically simplified and in the case of which the time delay between issuing and executing the command can be minimized in spite of this simplified construction. In addition, the time of effect of the command can be influenced in a simple way.

This object is achieved according the invention by the features cited in the characterizing part of Patent Claim 1.

The system according to the invention is constructed very simply. The transverse thrust generator is by means . . .[Translators note: lines omitted].

Tit is advisable to drive the transverse force thrust generato /6
into the other position by means of the transverse force thrust generator itself. Rotary nozzles with acentric thrust nozzles, in the case of which this transfer takes place in a turning motion, or also longitudinally movable thrust nozzles, that are pushed driven by the gas of their own propellant charge after releasing the connection with the tension element, are suitable for this.

For example, electrically conducting wires or strips, that have a nominal melting point, are considered as tension element. If an electric current is sent through the wire, respectively the strip, the connection is broken at the nominal melting point. Also, melting wires are used. A particularly rapidly released connection between tension element and thrust generator is created when a rotary nozzle is used as a thrust generator and a tension element wrapping around the rotary nozzle is used as a tension element, that preferably consists of a heat-sensitive metal alloy. If a current is sent through this loop, the tension element stretches very rapidly and thus releases the rotary nozzle held by friction up to now.

Of course, the tension element can also be separated mechanically by mini-Kapp blades.

The miniaturizable transverse force thrust generator in each case have, for example, their own propellant charge, that generates the transverse force after ignition, and also transfers this force into the respectively other position after releasing the connection. This creates a very small autonomous system, that can be used at very

different points on the missile.

An extremely fast-acting version consists of transverse force thrust generators, that are supplied together and simultaneously from a central hot gas generator, preferably distributed on the circumference of the missile. The weight of the parts of the /7 transverse force generator that participate in the motion of moving into the other position, and thus also the inertia of these parts, is very small. If all transverse force thrust generators eject thrust jets of equal action, the result is zero. The control, that is the generation of a specified transverse force, preferably takes place by the fact that the transverse force of two opposite thrust generators on the circumference of the missile, for example in each case rotary nozzles wrapped with an electrically expansible wire shortly one after the other, is switched off for example by loosening the wrapping. With this the often differently long time of the ignition of a charge is avoided. The improved reproducibility and thus the considerable shortening of a specific transverse force efficiency is ensured by the same control method, in this case both times loosening the wrapping for switching on the transverse force and switching off the transverse force.

Moreover, it is possible to hold the transverse force generators by several tension elements of different length, the length of which is specified so that, after loosening the connection of the first tension element, the transverse force thrust element is held by a second tightened tension element after moving into another position.

After loosening this connection, the transverse force generator is held in a third position, and so forth.

Advantages of the invention are, beside the simplicity of the miniature system, the possible extremely short dead time between issuing and executing a command, and the low-inertia braking and releasing system. In the case of using sever rotary nozzles with an installed thrust charge, the otherwise necessary rotation, that is necessary in the case of a common hot gas source for several thrust systems, also can be omitted.

Further configurations of the invention follow from the sub-claims. Several embodiments of the invention are explained in greater detail by means of the drawing. In the drawing: /8

Fig. 1 shows a schematic perspective view of a system for steering a missile according the invention;

Fig. 2 shows a section through a missile nose with a system for missile steering according to the invention;

Fig. 3 shows a longitudinal section through a missile nose with several systems for missile steering;

Fig. 4 shows a detailed representation of a modified system for missile steering;

Fig. 5 shows a section along V-V in Fig. 4;

Fig. 6 shows a partial cross-section through a missile nose with a further system for missile steering.

Figs. 1 and 2 show a system **1** for steering a missile, that has a rotary nozzle arrangement **2** mounted capable of turning around an axis

A as well as a holding and releasing device 3. The rotary nozzle arrangement 2 has a long essentially cylindrical housing 4, in the longitudinal axis A of which a cartridge 5 for a propellant charge 6 is located. The propellant charge 6 is to be ignited electrically via a primer 7. The cartridge 5 opens in the area of the primer into an acentric thrust nozzle 8, from which a heating gas jet emerges approximately radially in the direction of the arrow S at the time of burning off the propellant charge 6. The direction of action of the hot gas, respectively thrust jet 5, passes at a radial distance r /9 from the longitudinal axis A, so that a torque is generated during the burn-off of the propellant charge 6 on the rotary nozzle arrangement 2, through which torque the rotary nozzle arrangement is driven in the clockwise direction around the longitudinal axis A in Figs. 1 and 2.

The rotary nozzle 2 is held in a fixed turning position by means of an electrically conducting fuse wire 9, in which position the acentric thrust nozzle 8 lies directly opposite an exhaust opening 10 in the wall of a missile 11. If the propellant is ignited in this turning position, a transverse force acts on the missile 11 through the thrust jet S in the direction opposite arrow 5. The electrically conducting wire 9 is wrapped around the circumference of the housing 4 of the rotary nozzle, stretched tight, and in each case both of its ends attached to the missile 11, as is shown schematically in Fig. 1. The tightening of the wire 9 and the friction between wire and rotary nozzle housing 4 are determined so that the rotary nozzle is held in

the position according to Fig. 2.

The two ends of the wire **9** are connected with each other electrically via a switch **12** and a battery **13**, the switch **12** being opened in the turning position of the nozzle according to Fig. 2.

If the switch 12 is closed, a short circuit is produced between the two ends of the wire, and a high current flows through the wire **9**, because of which the wire becomes greatly heated, expands correspondingly, and finally melts. The connection between fuse wire 9 and rotary nozzle housing **4** is already loosened during the expansion phase, so that the rotary nozzle **2** turns out of the direction of action according to Fig. 2 around axis A because of the torque. A stop **14** is provided on the rotary nozzle housing **4**, and a stop **14** is provided on the missile **11**, onto which the stop **14** runs during the rotation of the nozzle. The hot gas flowing out of the acentric /10 thrust nozzle **8** is caught in a collecting duct **16** and blown out of the missile **11** in a neutral direction.

The action of the transverse force on the missile **11** is determined by the period of time in which the rotary nozzle **2** is held in the turning position indicated in Fig. 2. The actual effect of the transverse force is accordingly determined by a reduction of the maximum time of action corresponding to the total burning time of the propellant charge **6**. The shortest pulse is generated when the connection between fuse wire **9** and rotary nozzle is already released before the ignition of the propellant charge.

Fig. 3 shows that a plurality of such controlled rotary nozzle

arrangements **2** are distributed on the circumference of the missile. The acentric thrust nozzles **8** next blow thrust jet via the duct with the exhaust opening **10**, the thrust jets of all rotary nozzles being of equal effect, so that no force is exerted on the missile as a whole. If a transverse force is generated in a specific direction, a rotary nozzle is switched off on the opposite side, by releasing the wire connection **9**. In this case, switching on two opposite-lying rotary nozzles in overlapping fashion also can take place, so that a very short-term transverse force pulse can be triggered. In the inactive position of the rotary nozzle **2**, the thrust nozzle blows the hot gas into a common circular collecting duct **16**, from which the hot gas then is blow out in a direction-neutral fashion through the openings **21** passing obliquely to the rear.

Figs. 4 and 5 show a modified rotary nozzle **2'**, that has no propellant charge of its own, but is supplied by a gas generator not shown here, that blows hot gas into the rotary nozzle along the arrow shown in Fig. 4. Accordingly the rotary nozzle arrangement **2'** consists essentially only of a cylindrical thrust nozzle part and a /11
cylindrical bearing part, as follows from Fig. 4.

According to Fig. 5, the rotary nozzle has three thrust nozzles **8'** distributed on the circumference, which nozzles in each case are offset by the distance r' with respect to the axis of rotation. In the representation of the rotary nozzle **2'** shown in Fig. 5, one of the thrust nozzles **8'** is opposite an exhaust opening **10'**, so that a thrust jet **8'** is generated when the gas generator is burned. If the nozzle

turns further in the counter-clockwise direction after release, the acentric thrust nozzle **8′** stands opposite a collecting duct **16′**, from which the emerging hot gas is removed in a direction-neutral fashion similar to Fig. 3.

The rotary nozzle **2′** is held and released by several electrically conducting tension wires **9-1** to **9-6** of different lengths. On the one hand, these wires are attached on the circumference of an electrically conducting extension **22** of the rotary nozzle and, on the other hand, on the missile **11′** with soldering points **23**, that serve as nominal melting points. In each case, current circuits containing a switch and a battery are provided between the soldering points and the cylindrical extension **22** similar to the specific embodiment according to Fig. 1.

According to Fig. 4, the rotary nozzle **2′** is held by means of the first tension wire **9-1** in a turning position according to Fig 5, in which the thrust jet S′ of this rotary nozzle **2′** exerts a transverse force on the missile **11′**. If the transverse force no longer acts, the circuit for the wire **9-1** is closed so that the soldering point **23** breaks and the rotary nozzle **2′** rotates in the counter-clockwise direction. This is possible only until the second wire **9-2** is tightened and thus stops the rotary nozzle **2′**. The length of this wire is determined so that the acentric thrust nozzle **8′** active up to now stands opposite the collecting duct **16′** and the next thrust nozzle does not yet stand opposite the exhaust opening **10′**. If the circuit /12

is closed for the wire **9-2**, the rotary nozzle **2′** turns further after the release and is stopped by the following wire **9-3** in a position in which now the second acentric thrust nozzle stands opposite the exhaust opening **10′** and again exerts a thrust. In this way, the tension wires of different lengths **9-1** to **9-6** make it possible to have six turning points, three of which are effective turning positions, in which a transverse force is exerted.

The wires with which the rotary nozzle is held, can also be separated mechanically, as is indicated in Fig. 4 for wire **9-5**. For this it is possible to use a miniature Kapp blade Z4, that is actuated pyrotechnically.

Fig. 6 shows a further transverse force thrust generator **2′**, that is located in a missile nose **11′** and is longitudinally movable along an axis A″ parallel to the longitudinal axis of the missile nose **11″**. The transverse force thrust generator **2″** has a piston **25**, that is mounted sliding in a cylinder bore **26** with the axis A″. In the interior of the cylinder piston **25** there is a propellant charge **6″**, that can be ignited electrically by means of a primer **27**. The cylinder piston **25** is held by means of a tension wire **9″** stretched tight on its bottom so that a nozzle **8″** branching from the propellant charge housing communicates with an exhaust opening **10″** on the circumference of the missile **11′**. If then the propellant charge **6″** is ignited, a thrust jet S″ is generated. The electrically conducting tension wire **9″** is guided over also electrically conducting pins **28**,

that for their part are grouped with a battery **13″** and a switch **12″** to a circuit containing the tension wire **9″**.

A thinner duct **29**, that in the axis A″ is connected to the chamber, which holds the propellant charge **6″**, pushes the bottom of /13 of the cylinder piston **25** turned toward the tension wire **9″**. The opening of this duct **29** lies on a sealing seat **30**, so that no propellant gas can emerge via this duct **29**, as long as the cylinder piston **25** is held by the tension wire **9″** in the position according to Fig. 6.

However, if the switch **12″** for switching off the thrust S″ is closed, the tension wire **9″** expands so that the opening of the duct **29** raises slightly from the sealing seat **30**. Propellant gas now emerges through the duct **29** and pushes onto the bottom of the cylinder piston. In this way the latter is pushed to the right in Fig. 6. In the interim, the tension wire **9″** also is melted through, so that the motion to the right is stopped as soon as the cylinder piston **25** stops on the right-hand wall of the recess **26**. In this position a further outlet nozzle **31**, that departs radially from the chamber containing the propellant charge **6″**, is connected with a collecting duct **16″** in the interior of the missile, while the thrust nozzle **8″** is covered by the wall of the recess **26**, and no more propellant gas flows through the exhaust opening **10″**. The collecting duct **16″** removes the propellant gas in a direction-neutral fashion.

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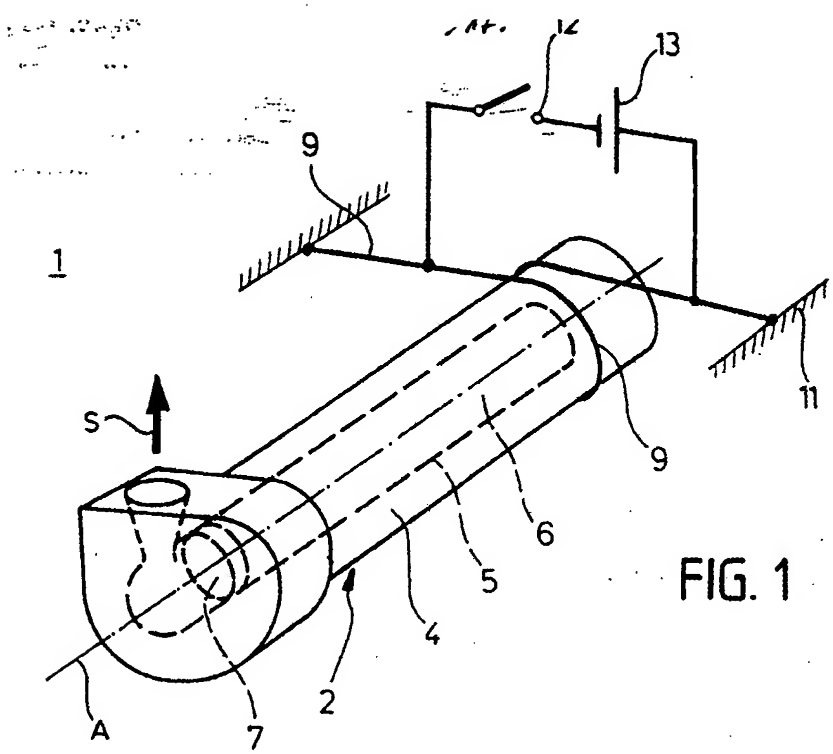


FIG. 1

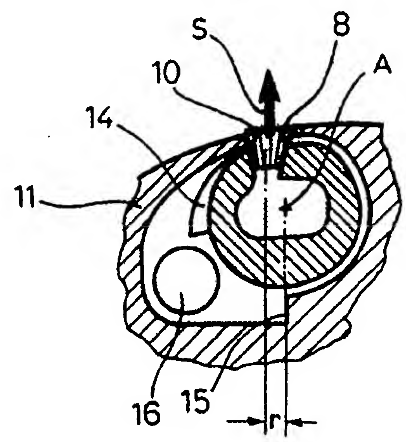


FIG. 2

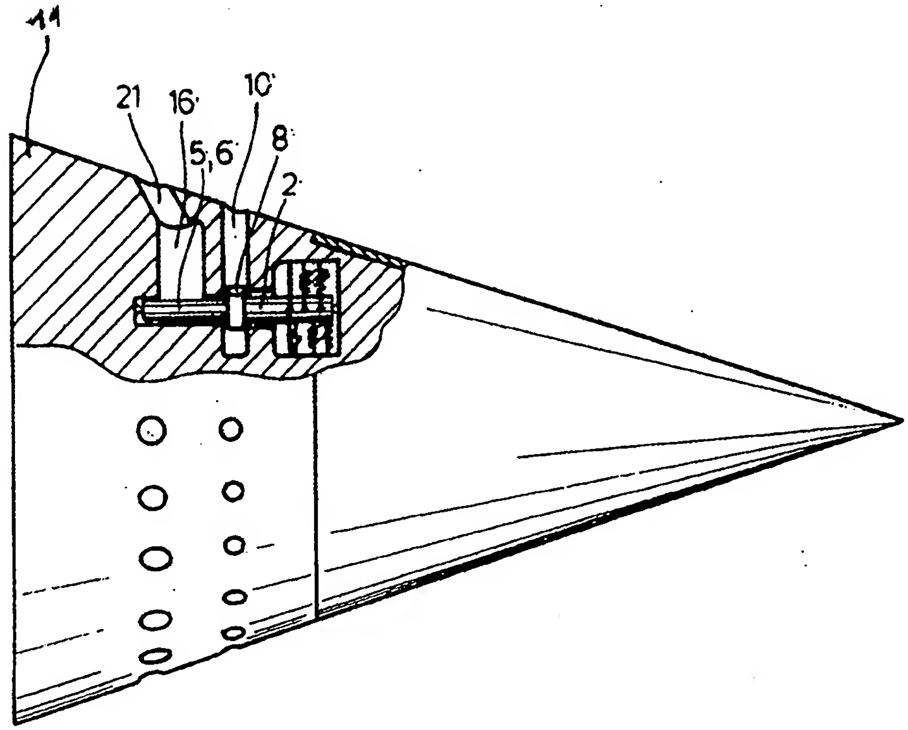


FIG. 3

FIG. 4

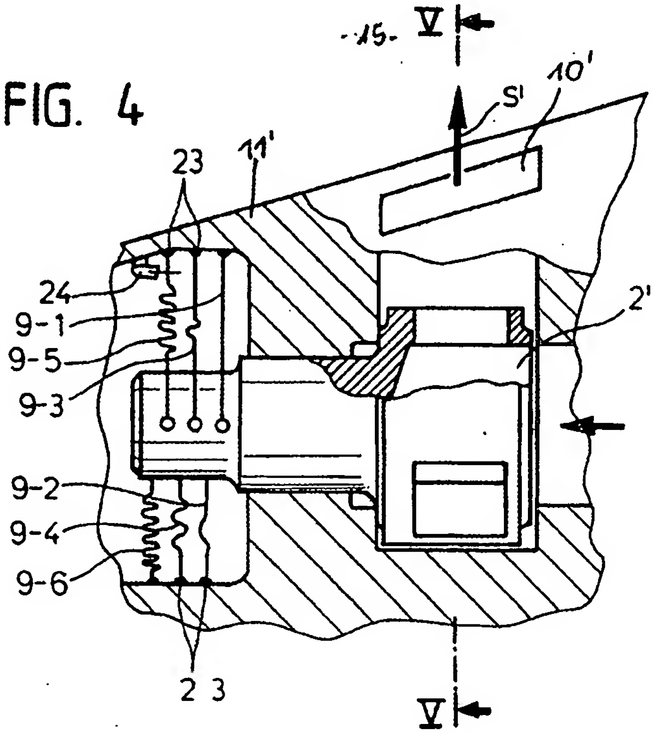
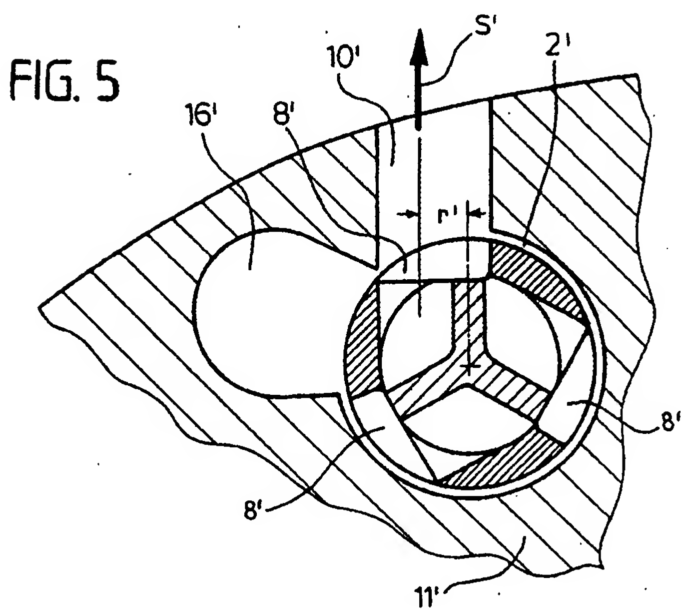


FIG. 5



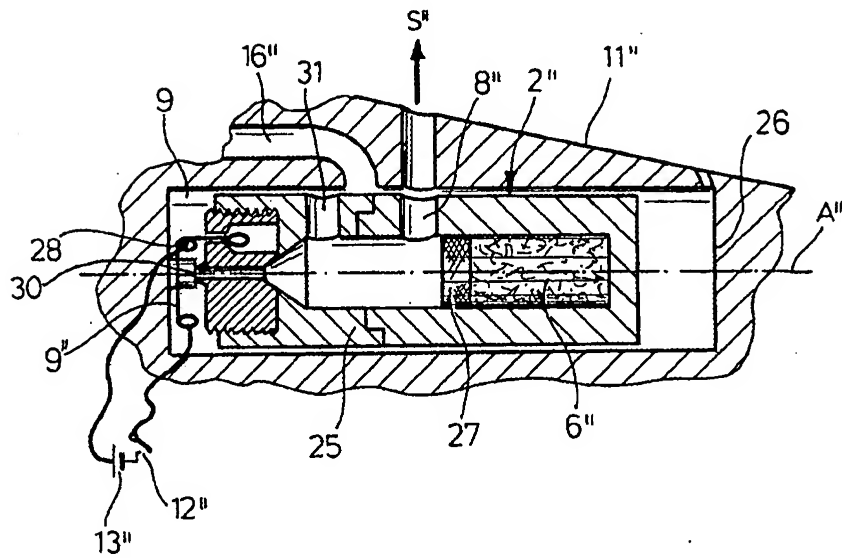


FIG. 6